Attachment 1

Compliance Evaluation
for the Savannah River Site
Saltstone Disposal Facility Performance Assessment

The Low-Level Waste Disposal Facility Federal Review Group (LFRG) has determined the *Performance Assessment for the Savannah River Site Saltstone Disposal Facility* (SRR-CWDA-2009-00017, R0), hereafter referred to as the Saltstone PA, is acceptable. This conclusion is based on the 2009 Saltstone Performance Assessment (PA), the Review Team report for the Saltstone PA, and the resolutions described in that report.

This PA differs in several respects from the low-level waste (LLW) disposal facility PAs normally reviewed by the LFRG. This PA supports disposal of low-level waste (LLW) in improved cylinder vaults at the Saltstone Disposal Facility (SDF). The former Secretary of Energy determined that the waste was not high-level waste under Section 3116(a) of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, and under Section 3116(b), the Nuclear Regulatory Commission (NRC), in coordination with the State of South Carolina, monitors such saltstone disposal actions for compliance. Section 3116 determinations require compliance with the relevant provisions of Department of Energy Manual 435.1-1 (DOE M 435.1-1) plus the performance objectives in 10 Code of Federal Regulations (CFR) 61.40 through 61.44. In contrast, DOE LLW disposal facilities need only satisfy the DOE M 435.1-1 performance objectives. As a matter of policy to support Section 3116(b) monitoring, this PA was provided to and reviewed by staff from the Nuclear Regulatory Commission (NRC). Based on the NRC review and two rounds of NRC Requests for Additional Information (RAIs), some clarification on the PA assumptions and modeling has been developed and provided to the LFRG for use in voting on the approval of the PA.

Three key and 28 secondary issues were identified as a result of the Review Team review. The Savannah River Site (SRS) submitted additional information during its factual accuracy review to address and resolve the three key issues. Twenty-four of the 28 secondary issues were addressed in SRS's responses during the factual accuracy review. These responses have been incorporated into the PA revision. The remaining four secondary issues not resolved in the revised PA are addressed by the PA maintenance program. The Review Team identified five noteworthy practices associated with the PA, which have been passed on to the Community of Practice to aid in future PA development.

The point of compliance (POC) for the Saltstone PA for salt waste disposal during the 100-year institutional control (IC) period for the all pathways, drinking water standards, and air pathway performance objectives/measures is calculated for the maximum groundwater concentrations present at 100 meters from the SDF. The radon performance objective POC is at the facility surface during the IC and compliance period (1,000 years). The water quality resources performance measure POC remains the point of highest projected dose or concentration beyond a 100-meter buffer zone surrounding the disposed waste during the IC and compliance periods.

The inadvertent intruder performance measure POC will be at the disposal facility, after the assumed loss of active ICs throughout the compliance period.

As shown in the results for SDF Performance Objectives, in Table 1 and Table 2, all performance objectives/measures are satisfied. Table 1 describes the Analysis Results for the SDF Performance Objectives as Analyzed in the PA (Table 1), concerning the NRC performance objectives at 10 CFR 61.40 - 61.42 and DOE M 435.1-1 requirements. Table 2 shows the Analysis Results for SDF Performance Objectives and Requirements Concerning Protection During Operations and Site Stability that is, the "Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site" [DOE-WD-2005-001]), concerning DOE requirements and the NRC performance objectives at 10 CFR 61.43 and 61.44. Table 3 was added to provide a status of the four outstanding secondary issues raised in by the LFRG review team. The LFRG reviewed these issues and understands the long-term studies and inclusion of them in the PA Maintenance Plan. The PA was judged to provide a reasonable expectation that the DOE M 435.1-1 performance objectives and performance measures will not be exceeded.

As Low As Reasonably Achievable (ALARA) Analysis

The Saltstone PA demonstrated that the projected releases of radionuclides to the environment will be maintained ALARA.

Table 1: Analysis Results for Salt Disposal Facility Performance Objectives as Analyzed in the Performance Assessment

Performance Objective	Limit	PA Result*
10 CFR 61.40, "General Requirement"	Reasonable Assurance that after closure, exposures to humans will be within the limits established in 10 CFR 61.41 through 10 CFR 61.44.	The PA was developed under DOE guidance and requirements which require that the analysis provide a "reasonable expectation" that the performance objectives will not be exceeded as a result of operation and closure of the facility. An uncertainty and sensitivity analysis was performed to identify parameters that have the greatest impact on the results. Overall, additional work will improve confidence that exposures to humans will be within the limits of the 10 CFR 61 performance objectives.
10 CFR 61.41, "Protection of the General Population from Releases of Radioactivity"	≤ 25 millirems (mrem)/year Total Effective Dose Equivalent (TEDE) whole body dose	1.4 mrem/year at 100 meters
10 CFR 61.42, "Protection of Individuals from Inadvertent Intrusion"	500 mrem	3.8 mrem/year – acute 1.9 mrem/year – chronic
DOE M 435.1-1, All pathways	25 mrem/year TEDE	1.4 mrem/yr at 100 meters
DOE M 435.1-1, Air pathway	10 mrem/year TEDE	< 4.0 x10-09 mrem/year at 100 meters
DOE M 435.1-1, Hypothetical inadvertent intruder	100 mrem/year from chronic exposure	1.9 mrem/year at subsurface disposal area
	500 mrem from a single event	3.8 mrem/year

Performance Objective	Limit	PA Result*
DOE M 435.1-1, Water resource protection	Combined Ra 226 and 228: 5 pCi/liter	1.9 pCi/liter
	Beta emitters: 4 mrem/yr	1.2 mrem/yr
	Gross alpha: 15 pCi/liter	1.9 pCi/liter
	Uranium: 30 µgm/liter	8.0 x 10-9 µgm/liter
Reasonable Assurance of Compliance with dose limits and ALARA	Measures providing assurance of compliance with dose limits and ALARA such as a radiation protection program, documented safety analysis, design features, enforcement mechanisms, access controls, training, and dosimetry.	The PA describes features that could contribute to reasonable assurance that the dose limits and ALARA will be satisfied.

* DOE M 435.1-1 PAs are required to project performance for 1,000 years.

Table 2: Analysis Results for SDF Performance Objectives and Requirements Concerning Protection During Operations and Site Stability

Performance Objective	Limit	3116 Basis Document Result*
10 CFR 61.43, "Protection of Individuals during Operations"	Various – See 10 CFR 20, 10 CFR 835, DOE O 440.1B, and DOE O 5400.5	(Results for individual subcriteria are described in the cells below.)
Air Emissions Limit for Individual Member of the Public [10 CFR 20.1101(d)]	10 mrem/year TEDE (excluding radon-222 and its daughters)	4.0E-09 mrem/yr, at 100 meters
Total Effective Dose Equivalent (TEDE) Limit for Adult Workers [10 CFR 20.1201(a)(1)(i)]	5 rem/year TEDE	The facility is subject to 10 CFR 835.202(a)(1) which imposes an equivalent requirement.
Any Individual Organ or Tissue Dose Limit for Adult Workers [10 CFR 20.1201(a)(1)(ii)]	50 rem/year	The facility is subject to 10 CFR 835.202(a)(2) which imposes an equivalent requirement.
Annual Dose Limit to the Lens of the Eye for Adult Workers [10 CFR 20.1201(a)(2)(i)]	15 rem/year	The facility is subject to 10 CFR 835.202(a)(3) which imposes an equivalent requirement.
Annual Dose Limit to the Skin of the Whole Body and to the Skin of the Extremities for Adult workers [10 CFR 20.1201(a)(2)(ii)]	50 rem/year	The facility is subject to 10 CFR 835.202(a)(4) which imposes an equivalent requirement.
Limit on Soluble Uranium Intake [10 CFR 20.1201(e)]	10 mg/week	The facility is subject to DOE Order (O) 440.1B which imposes a stricter limit of 2.4 mg/week
Dose Equivalent to an Embryo/Fetus [10 CFR 20.1208(a)]	0.5 rem	The facility is subject to 10 CFR 835.206(a) which imposes an equivalent requirement.

Performance Objective	Limit	3116 Basis Document Result*
Dose Limits for Individual Members of the Public [10 CFR 20.1301(a)(1)]	0.1 rem/year TEDE	The facility is subject to DOE O 5400.5[1] (Section II.1.a) which imposes a stricter requirement.
Dose Limits for Individual Members of the Public [10 CFR 20.1301(a)(2)]	0.002 rem/hour TEDE	The facility is subject to 10 CFR 835.602 and 10 CFR 835.603 which impose a stricter requirement.
Dose Limits for Individual Members of the Public [10 CFR 20.1301(b)]	In controlled areas, members of the public limits apply to members of the public.	The facility is subject to 10 CFR 835.208, which imposes an equivalent requirement.
As Low As Reasonably Achievable (ALARA) [10 CFR 20.1101(b)]	ALARA compliance	The facility is subject to 10 CFR 835.2, which imposes an equivalent requirement.
10 CFR 61.44, "Long-Term Stability of Disposal Site"		
(a) Siting	Description and evaluation of relevant site characteristics including demography and natural resources with respect to long-term stability and potential for human intrusion.	Chapter 3 of the PA includes comprehensive descriptions, including associated references of site geography, demography, meteorology, climatology, ecology, geology, seismology, volcanology, hydrogeology, geochemistry, and natural resources sufficient for qualitative or quantitative evaluation, as appropriate, of site stability.
(b) Design	Description and evaluation of vaults and ancillary equipment design (e.g., materials of construction, configuration, size, and closure grout).	The PA provides detailed descriptions of the current disposal vaults and future disposal cells and the concrete support and shielding features. It also provides information necessary to assess the long-term behavior of the vaults and future disposal cells.

[1] This Order is now DOE Order 458.1

Performance Objective	Limit	3116 Basis Document Result*
(c) Use/Operation	Description of considerations for performing current and future operational activities that is relevant to ensuring long-term stability of the facilities and waste form.	The expected curie content of the salt waste stream is generally well understood. Operation and use of the future disposal cells is expected to be iterative and to incorporate lessons learned from earlier cells into later applications.
(d) Closure	Description of plans for closure of the disposal vaults that demonstrate suitable long-term resistance of the vaults and the waste form to degradation and loss of structural integrity.	The analyses performed demonstrate reasonable assurance that the waste grouted in the Saltstone disposal vaults and future disposal cells will likely satisfy the relevant performance objectives over the required period of performance. Such stability will prevent subsidence, water infiltration, and radionuclide release.

Table 3: April 2012 Status of Outstanding Secondary Issues Identified in the November 2010 LFRG Review Team Report

	Secondary Issue	Previous Response	Updated Response
S5	Section 3.2.1.3.6 states that the bentonite in the Geosynthetic Clay Liner (GCL) is expected to remain mineralogically and chemically stable. This assumption needs to be justified. For example, replacement of Na by divalent cations is thermodynamically favorable in bentonite and occurs rapidly (<5 years) in GCLs used in composite barriers (Meer and Benson 2007, Benson et al. 2009). Thus, chemical stability may not be realized. Has the mineralogical stability of bentonite (or smectites in general) been evaluated for conditions comparable to these values? Perhaps natural analogs exist for bentonites/smectites that can be used to validate this assumption.	This work will be added to the FY 2010 Saltstone PA Maintenance Plan activities.	Section 2.3.3.10 of the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program – FY2012 Implementation Program* (SRR-CWDA-2012-00020) describes future plans for testing and analysis of the GCL as part of the closure cap drainage layer. While the GCL is expected to remain stable, the basis for modeling the GCL degradation/infiltration for the GCL in the closure cap, above the drainage layer and below the disposal unit utilize the degradation methodology in WSRC-STI-2008-00244. The methodology does not assume the chemical stability in the modeling parameters but assumes conversion to a calcium or magnesium bentonite with a higher hydraulic conductivity (Section 6.7.4). Because of the conservative modeling assumptions, there is low risk of impacts relative to the performance objectives but the future maintenance activity can allow the removal of the utilized conservatism.
S12	The high salt content of Saltstone pore waters (~28 weight percent) means that the initial pore waters have a matric potential on the order of 300 bars. This order of differential pressure, if actualized, could physically disrupt the Saltstone and vaults. Additionally, the osmotic potential could lead to water uptake and weeping of the Saltstone. Very limited information and conceptual understanding are available to ascertain the importance of this mechanism to release and longevity but it appears it may be potentially significant.	This work will be added to the FY 2010 Saltstone PA Maintenance Plan activities.	Section 2.3.1.8 of the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program – FY2012 Implementation Program* (SRR-CWDA-2012-00020) identifies future maintenance activities focused on determining the effects of osmotic pressure on saltstone performance.

	Secondary Issue	Previous Response	Updated Response
S23	The uncertainty ranges used for inputs to GoldSim are generally based on professional judgment. While this is appropriate given the lack of information, it appears that some uncertainties should be reevaluated, for example, the saturated zone Darcy velocity has a standard deviation of about 10 percent of the mean value. Similarly the K_d range is about factor of 0.5 to 1.5 times the geometric mean for clayey soils. These uncertainties imply a confidence that testing data may not support in such a heterogeneous natural environment. However, it is also possible that the nominal value selected (for example, for plutonium sorption) may be conservative and the uncertain range not representative.	Section 8.2 identifies future work in the area of stochastic distribution parameters. This work will be added to the FY 2010 Saltstone PA Maintenance Plan activities.	Sections 2.3.1.1, 2.3.1.2, 2.3.1.3, and 2.3.1.5 of the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program – FY2012 Implementation Program* (SRR-CWDA-2012-00020) identify completed and ongoing maintenance activities focused on refining stochastic distributions for important parameters, such as K_d values in cementitious materials and soils. Additional science work has been conducted as documented in the maintenance plan including Technetium Kd testing, Kd distributions in cementitious materials, and Kd distributions in soils which support the conclusions in the PA. Because of the conservative modeling assumptions, there is low-risk that uncertainty ranges will cause the system to exceed the performance objectives. However, the future maintenance activity is appropriate to better characterize this uncertainty and either confirm the current assumptions used in the PA or produce additional information to support a revised PA.
S27	Natural system behavior is uncertain and spatially variable. It is believed that site specific information and relevant analogs should be used for development of reasonable uncertainty distributions for flow and transport models. This information should appropriately distinguish between natural system variability and uncertainty. In the current analysis, the variability in natural system (and engineered system) behavior is generally not considered. While this is appropriate at the current stage of development and validation of the process models used to support the PA, there should be an explicit acknowledgement of the distinction between parameter uncertainty and parameter variability in the document. For example, the	This work will be added to the FY 2010 Saltstone PA Maintenance Plan activities.	Section 2.3.1 of the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program – FY2012 Implementation Program* (SRR-CWDA-2012-00020) describes testing targeted at reducing uncertainty in properties critical to the PA using site-specific values whenever possible. Section 2.3.3.6 also describes a long-term lysimeter program intended to better mimic waste release in the natural system.

	Secondary Issue	Previous Response	Updated Response
	PORFLOW model validation illustrated in Figure 4.4-57 is probably related to complex variability in the modeled source term and vadose zone hydrologic properties in the vicinity of the Vadose Zone Monitoring System. Finally, SRS should consider redefining what is meant by the phrase "model validation" or embrace recent National Research Council and U.S. Environmental Protection Agency guidance on model confidence, where the concept of "model evaluation" is used to describe the necessary confidence in the model for making regulatory decisions during the life-cycle of the model and the project.		